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# Measurement of photon and "phonon" transport using bi-material cantilevers

Bi-material microcantilevers, with their high sensitivity to thermal stimuli, are well known as thermal sensors. Though they have been used for more than two decades as heat flux and/or temperature change sensors, they have only recently been used to measure thermal transport. In this talk, I will discuss our work on (1) measurement of near-field thermal radiation (photon transport), and (2) measurement of heat flow across individual polystyrene nanowires.

Our first use of bi-material cantilevers as a thermal transport sensor was to measure heat flow due to near-field thermal radiation between a sphere attached to the cantilever and a flat substrate. After a brief discussion of these measurements, I will talk about the measurement of heat flow through an individual nanostructure. To achieve this, we have designed and fabricated low thermal conductance bi-material microcantilevers by minimizing their width and thickness. Using such cantilevers, we have demonstrated heat flux resolution of less than 1 picowatt. A pair of such cantilevers is proposed as a configuration for measuring thermal conductance of a nanostructure suspended between the two. In our cantilever technique, two lasers are focused, one on each cantilever. One laser is modulated to vary the temperature at the end of one cantilever, while the second laser senses variation in heat flow through the second cantilever due to thermal conduction along the nanowire. We have measured the stray conductance between the cantilevers, i.e., the spurious conductance measured when no object is suspended between the two cantilevers, to be less than 0.05 nW/K.

Segments of electrospun polymeric nanowires are suspended between the two cantilevers and the heat flow through such nanowires is quantified by measuring the deflection of the sensing cantilever for a known, laser-induced deflection of the sensing cantilever. Results of measurements from polystyrene nanowires will be presented. The deflection of the sensing cantilever is influenced by two factors: (1) heat flow through the nanostructure, and (2) deflection because of mechanical coupling. We will discuss the effects of mechanical deflection and techniques to eliminate it.